



# NASA ASTROBIOLOGY INSTITUTE ANNUAL REPORT YEAR [July 2002 - June 2003]



Focus Groups: Titan

<b>Focus Group:</b>	<b><i>Titan</i></b>
<b>Project Title:</b>	<b><i>Titan</i></b>
<b>Chair:</b>	<b><i>Jonathan Lunine</i></b> <a href="#">[view project member list]</a>

## Project Progress

Since the discovery of a methane atmosphere around Titan by Gerard Kuiper in 1944, Titan has been a world that has attracted much exobiological interest. Titan provides us with a planet-sized laboratory for testing the synthesis of organic compounds in a nearly neutral redox environment, over large spatial scales, both with and without liquid water. These natural chemical experiments could be ongoing today, and the products of such experiments in localized regions of elevated temperatures would be well preserved under the ambient 95 K temperatures and high atmospheric densities that shield the surface from destructive radiation.

The Cassini–Huygens mission will make a complete inventory of the surface from a variety of remote sensing and in situ techniques, over the time period late 2004 through late 2008. The Huygens atmospheric probe will descend to the surface in January 2005. Before and after that the Orbiter will undertake some 45 close flybys of Titan. The result of the Cassini–Huygens mission will be a level of understanding of the geology, geodesy, atmospheric physics and surface–atmosphere interactions on Titan rivaling that for Mars after the Mars Global Surveyor (MGS) mission (with the exception of a lack of a detailed global altimetric map of the body). Further, Cassini–Huygens will provide us with information regarding the distribution and nature of organics spread across the Titan surface. If surface compositional variations are found in the organics, especially correlated with apparent geologic activity or crustal melting, the interest in returning to Titan to sample those interesting places directly, for signs of oxygen-bearing organics like amino or carboxylic acids for example, will be high.

Indeed, NASA has already expressed interest in initial planning for a post–Cassini mission to Titan, and it appears likely that such a mission will be high on the list of astrobiologically interesting programs in the planetary decadal strategy now being prepared. It has become standard operating procedure for the NAI to play a key role in mission planning for astrobiologically interesting targets in part or in whole through conduct of focus groups. The Mars and Europa groups have been very effective in this regard. It is natural, then, that a similar effort be undertaken for Titan, and the timing is appropriate given NASA's interest in post–Cassini mission planning, and the

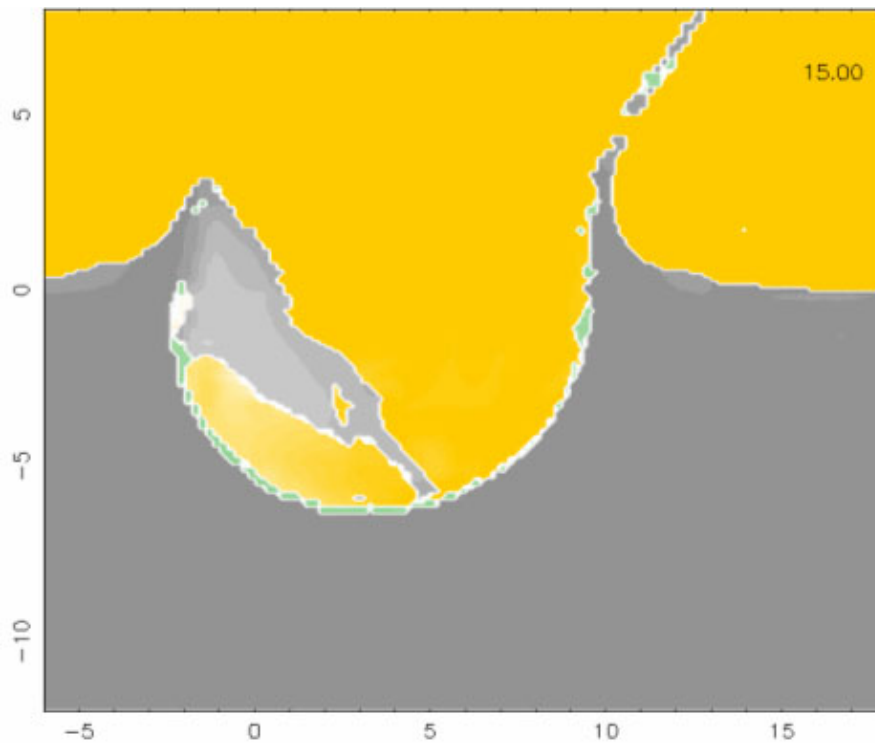
imminent arrival of Cassini–Huygens at Saturn.

The Titan Focus Group is open to all interested parties, but all individuals who desire to participate are asked to identify themselves, their institution, and to commit to a certain amount of time and activity. Hence casual chat room browsers is to be discouraged. Most of the work of the group is by e–mail, but two or three meetings of the focus group organized around convenient ancillary meetings (such as the NAI annual meeting) are conducted.

The four topical areas that shape the four white papers are staggered in time over the three years of the Titan Focus Group (TFG), and are organized in a logical intellectual order. The TFG is first considering the questions that motivate the astrobiological exploration of Titan, and generate a sharply focused set of scientific questions and objectives that will constrain the kinds of techniques to be applied post–Cassini. Once this is accomplished, the TFG will move into the phase of considering the techniques that should be used in the exploration of Titan beyond Cassini–Huygens, with a focus on the analysis of the organic chemistry of the surface. The effort is constrained by the results of a number of recent experimental studies. Experimental organic chemists, and not merely "Titanophiles", are involved in the TFG to ensure that this second topic reaches a realistic conclusion, and they will be actively sought. The third topic depends on the successful completion of the second. It concerns the types of missions to be conducted after Cassini–Huygens, as well as the types of analyses of Cassini–Huygens data required to constrain the next mission. Hence science payloads will be considered and winnowed down into a prioritized list, recommendations on number and types of sampling sites will be made, and explicit discussion of how Cassini–Huygens data should be used will occur to decide on the timing and scope of the mission as well as potential landing sites. Finally, as Cassini–Huygens begins its observations of Titan next year, the TFG will shift its attention to considering the early results from the first 8 flybys of Titan, and the Probe mission.

Our first topical area was tackled at the NAI conference in Tempe in February. A map of potential questions to be addressed by a follow–on Titan mission was sketched, and will be worked on further this fall. A necessary hiatus in the discussion has resulted from the NASA solicitation for "Vision missions", follow–ons to the current cohort of space science missions under study. A Titan organics mission is among these, and many focus group participants are involved in mission proposals. Until these are submitted, a self–imposed "blackout" on exchange of proprietary ideas is necessary and will end in September when proposals are due.

Work on aqueous environments that might exist on Titan during impacts resulted in a confirmation of earlier analytic modeling that showed 2–5% of a newly–formed crater (by volume) will be liquid after impact (assuming initially a water ice composition). Exploration of the implications for prebiotic activity on Titan will be discussed and pursued among the group.



**Figure 1** 15 seconds into a multi-kilometer per second impact of a comet on Titan, green areas show where liquid water may be present. From Artemieva and Lunine, in press (*Icarus*).

### Focus Group Description & Activities

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Arrangements for a conference on future Titan missions to be held in Tucson were made in coordination with Cassini Project personnel, and will highlight Focus Group discussions.

### Highlights

- Titan focus group recommends follow-on organic analyses of the surface after the Cassini-Huygens mission.
- Numerical simulations of impact processes on Titan suggest the existence of transient liquid water in places on the surface of this organic-rich moon.

## Roadmap Objectives

- [\*\*Objective No. 2.2:\*\* Outer Solar System exploration](#)
- [\*\*Objective No. 3.1:\*\* Sources of prebiotic materials and catalysts](#)
- [\*\*Objective No. 3.2:\*\* Origins and evolution of functional biomolecules](#)
- [\*\*Objective No. 4.1:\*\* Earth's early biosphere](#)
- [\*\*Objective No. 7.1:\*\* Biosignatures to be sought in Solar System materials](#)

## Mission Involvement

<b><i>Mission Class*</i></b>	<b><i>Mission Name (for class 1 or 2) OR Concept (for class 3)</i></b>	<b><i>Type of Involvement**</i></b>
1	Cassini	Co-I's, Team Members, Interdisciplinary Scientists
2	NASA Vision missions	Multiple proposers

\* Mission Class: Select 1 of 3 Mission Class types below to classify your project:

1. Now flying OR Funded & in development (e.g., Mars Odyssey, MER 2003, Kepler)
2. Named mission under study / in development, but not yet funded (e.g., TPF, Mars Lander 2009)
3. Long-lead future mission / societal issues (e.g., far-future Mars or Europa, biomarkers, life definition)

\*\* Type of Involvement = Role / Relationship with Mission

Specify one (or more) of the following: PI, Co-I, Science Team member, planning support, data analysis, background research, instrument/payload development, research or analysis techniques, other (specify).

As Cassini-Huygens begins its observations of Titan next year, the TFG will shift its attention to considering the early results from the first 8 flybys of Titan, and the Probe mission, to assess implications for targeting of future probes to astrobiologically significant sites.